FETC Perspective on the DOE Stationary Power Fuel Cell Program

Rita A. Bajura
Director, Federal Energy Technology Center
U.S. Department of Energy

Good Morning, welcome to the *Fuel Cells '97 Review Meeting*.

Let me start with a few word about the Federal energy Technology Center — the FETC. As I am sure you know, last December, DOE merged the Morgantown and Pittsburgh Energy Technology Centers into the FETC. This merger was the result of a nationwide trend, in the words of President Clinton, for a ***smaller, humbler Government***.

We have responded. Our staff is down 15 percent over the past two years through attrition. We operate the FETC as if our two sites were co-located — thanks goodness for E-mail. A common management team serves both sites. Our programs typically span both sites. No more lead centers.

So you will start to see some fuel cell work in Pittsburgh office of the FETC. I'd like to introduce the FETC management team deal with fuel cells:

- Ralph Carabetta, my Deputy.
- Joe Strakey, heads the Office of Power Systems Product Management.
- Mark Williams is the Fuel Cell Product Managers in that office.
- Ken Markel heads the Office of Project Management.
- Chuck Zeh is Director of the Gas Power System Division.

Fuel cells! DOE/FE is responsible for the fuel cell program for stationary power. Our sister agency, DOE/Energy Efficiency & Renewable Energy, is responsible for fuel cells for transportation. This morning, I want to talk about:

- The status of DOE/FE's fuel cell program.
- Five trends and their impact on the future of the program

Status of Fossil Energy's Fuel Cell Program

Let me begin with the first ***real*** fuel cell success story — PAFCs!

From 1976 to 1992, the DOE and its predecessors invested $290 million to develop PAFCs. The Gas Research Institute, EPRI, and gas and electric utilities also invested in the development effort. ONSI Corporation, a subsidiary of International Fuel Cells (IFC), emerged

as the leading PAFC technology vendor. Currently, ONSI is actively marketing PAFC systems. More than 100 of their 200-kW systems are operating in countries around the world. Reliability has been excellent. Some have operated for more than 40,000 hours and are still going strong! Reducing the capital cost is the major issue for PAFC systems — as it is for ***all*** fuel cell systems. The ONSI unit sells for $3,000/kW; the goal is to reduce the cost to $1500/kW.

In 1996**,** FETC awarded grants for 42 of the 200-kW units. The Department of Defense provided this funding as part of the Administration's climate-change program. Here, the goal was to reduce CO_2 emissions by accelerating the commercialization of PAFCs. This year, DOD's Picatinny Arsenal is managing the buy-down program. DOD intents to award grants for 50 to 70 units before the end of this calender year.

DOE/FE is now out of the PAFC business. We focus on advanced fuel cells — MCFCs and SOFCs. These operate at higher temperatures than PAFC systems, have higher fuel-to-electric efficiencies, potentially lower capital costs, and can be integrated with coal gasifiers. DOE/FE's total FY97 funding for the MCFC and SOFC programs is $50 million. And we leverage this with an additional 40-percent cost-sharing from the private sector.

We are funding two major developers of MCFCs:

- Energy Research Corporation of Danbury, CT, and
- M-C Power Corporation of Burr Ridge, IL.

In FY97, we funded each of these developers at the $15 to 16 million level. Both of the developers conducted a major demonstration in 1996-97.

- ERC demonstrated a 2-MW unit at Santa Clara, California. This was the world's largest MCFC demonstration. It was also the largest, ***fuel cell*** power plant to operate in the U.S.

- M-C Power demonstrated a 250-kW demonstration at the Miramar Naval Air Station, near San Diego, California.

You will hear more about these two demonstration projects during this meeting. ***It is no secret*** that the original objectives for the two demonstrations were not ***all*** achieved. Fortunately, the problems encountered were not inherent to the technology. Rather, they were a normal part of the technology maturation process. Both MC-Power and ERC plan an additional demonstration project as part of the DOE program. They are still assessing sites.

FETC also funds SOFC technology. We currently support one major SOFC developer — Westinghouse — who, we feel, is the world leader in the SOFC technology. We are funding Westinghouse at the $12 million/year level in FY97.

Westinghouse made significant progress in reducing manufacturing costs of their tubular cells. They eliminated two electrochemical vapor deposition steps. Currently, Westinghouse is preparing for a **100-kW demonstration test** in the Netherlands, in January 1998. This will be the largest SOFC system tested to date. They are also planning (1) a 250-kW test at Southern

California Edison, (2) a 1-MW test at Ontario hydro, and (3) a 3-MW, demo at Fort Meade, MD sponsored by the EPA. This will be a coupled turbine/fuel cell system.

Five Trends and Impact on the Future of the Fuel Cell Program

I want to talk about five policy issues and then give some of my thoughts on how these issues might impact the fuel cell program.

Issue 1: Global Warming — *Greenhouse* Gas Emissions.

Let me put this into context: CO_2 concentration levels in the atmosphere have increased by 25 percent over the past 100 years. That is a fact. We are still debating — does this influence our climate? If it does, what will change? Will the changes result in a better or worse climate? What is the rate of change?

2,500 experts from more than 80 countries studied climate change as part of the United Nation's Intergovernmental Panel on Climate Change (IPCC). There is some disagreement over the final wording but their IPCC report stated:

The balance of evidence suggests a discernible human influence on global climate.

Where do we go from here? Developing countries do not want to limit their CO_2 ***until*** their standard of living catches up with developed countries.

But many developed countries want binding limits on CO_2 emissions. Binding limits are not that onerous for some developed countries.

- England — when they privatized their coal industry, they switched from high-cost, thin-seam coal to lower-cost North Sea gas;
- France — which is heavily nuclear;
- Germany — whose baseline in 1990 included the terribly inefficient East German plants that are already being upgraded;
- Japan — a compact nation with small cars and short commutes, and also high energy-efficiency because of long-standing, high energy prices.

Thus, the U.S. is under considerable pressure to commit to binding limits. The Administration has stated they want binding limits that are "flexible, cost-effective, realistic, achievable, and ultimately global in scope." They are currently negotiating binding limits with 130 other nations. The Administration plans to sign a greenhouse gas reduction treaty during a climate change meeting in Kyoto, Japan this December.

Meanwhile:

- Econometric models by Argonne and others show that binding limits would significantly reduce output and employment in six industries: Aluminum, Cement, Chemical, Steel, Petroleum Refining, and Paper and Pulp.

- Many, but not all, industry groups complain that binding limits will hurt the U.S. economy. They want more public debate on climate change. They want to see the specific details on the plan that the Administration will sign at Kyoto.

- The U.S. Senate voted 95 to 0 that they wanted ***both*** developing and developed nations to be covered in any climate change treaty negotiated by the Administration.

The concern over greenhouse gases is a threat for the fuel cell program. **Any technology that uses a carbon-based fuel is suspect**! And natural gas is a carbon based fuel.

But climate change concern is also an opportunity! In July, President Clinton announced a new initiative: A **Climate Change Technology Strategy**. He asked DOE to help plan this initiative, an initiative to seek low-cost technologies to address climate change. As we speak, DOE's laboratories — including FETC— are planning this initiative. The initiative will:

- Define roadmaps for addressing global warming.
- Identify technology targets.
- Scope out the needed R&D.
- Form industry-university-laboratory partnerships to carry out the R&D Program.

The scope of the initiative includes:

- Clean power generation — everything is on the table, including nuclear.
- Energy efficiency in the transportation, building, and manufacturing sectors.
- Long-range solutions for beyond 2025.

The planing schedule for this initiative is aggressive. DOE's goal is to deliver the completed plans for the initiative to the White House by October 1. We plan to start work on the Climate Change Initiative in FY98! Initially, the program could involve ***only repackaging*** of our current R&D activity. But depending on the level of Congressional and public interest, this ***could evolve*** into a major, new program!

I see this initiative as an opportunity for DOE and industry and academia to partner (1) to reduce the cost of fuel cells, and (2) to develop the ultra high-efficiency fuel-cell systems. Hybrid systems that couple gas turbines and fuel cells can slash CO_2 emissions in half compared with current, baseline systems. We can reduce CO_2 emissions even more by coupling high-efficiency power generation systems (1) with more efficient, end-use technologies; and (2) more efficient motors and buildings, the kind of technology DOE's Office of Energy Efficiency is developing.

Issue 2: Deregulation and convergence

Deregulation of the energy industry, both domestically and internationally, is forcing all segments of the energy industry to reduce. In response to this pressure to reduce costs, gas, electric, and oil companies are merging to become "energy companies."

Energy companies will build "energy plexes" — flexible plants that

- Consume gas or coal or waste material, and
- Produce a slate of products: electricity, liquid fuels, chemicals.

You are seeing this concept in Italy where Texaco is building three IGCC plants that will use a waste — refinery bottoms — to produce electricity and other chemicals.

DOE calls this concept Vision 21 — the plant for the 21st century. Vision 21 has a flexible design. It is tailored to meet the economics of a specific site. Vision 21 plants will have fuel-to-electric efficiencies higher than 60 percent. To achieve this efficiency level, the plant design includes a turbine/fuel cell combination.

In addition, Vision 21 plants will have no net CO_2 emissions. **No net CO_2 emissions!** In Vision 21, we are exploring CO_2 removal and sequestration. At a minimum, we need to develop information on the real cost and performance implications of removing and sequestering CO_2. This is a long-term effort. Possible sequestration techniques include:

- Reforestation projects.
- Deep ocean disposal in clathrate hydrates.
- Geologic disposal in depleted gas and oil reservoirs.
- Disposal in deep, un-minable coal seams.

I need to insert a touch of realism in this discussion on deregulation. Fuel cells have serious competition from competing technologies! Gas-fired reciprocating engines in the 50-kW to 5 MW size cost $200 to $350/kW. Lower-heating-value efficiencies are 35 percent. Thanks to work by GRI and others, NO_X levels are not that bad.

The message is that fuel cell costs must come down before fuel cells will be competitive in anything other than niche markets.

Issue 3: New R&D approaches ★ A new model for structuring R&D programs

Over the past few years, Congress and the Administration have had diametrically opposed views of R&D: **Congress** held that "basic research is good, and applied research is bad — it's corporate welfare." The **Administration** championed "technology partnerships with industry" as the cornerstone of economic development.

To solve this impasse, Congressional leaders are attempting to reach a consensus on a new R&D model — a model that would blur the border between basic and applied research. The

emerging model is based on partnerships among government, universities, and industry. The view is partnerships leverage the Government and the private-sector's investment in R&D. Industry involvement ensures the relevance of the R&D. The model calls for Consortia to:

- Focus on a defined problem — for example, develop a 60 mpg car.
- Cut across an industry — for example, all fuel cell manufacturers.

Industry produces a roadmap of technology needs and it may share ideas. This model suggests, but doesn't demand, that the research be pre-competitive. There is a whole range of potential opportunities for fuel cell consortia in pre-competitive R&D:

- Advanced manufacturing processes
- Advanced materials

I recognize that all three major developers in the DOE/FE program have an advisory group or a commercialization consortia that support their respective programs.

- ERC has the Fuel Cell Commercialization Group (FCCG).
- MC-Power has the Alliance to Commercialize Carbonate Technology (ACCT).
- Westinghouse has a 100-member fuel-cell advisory group.

Currently, EPRI is forming a new focused advisory group for Westinghouse. But the new R&D model I described may become a requirement. I invite your comments on how we can make it work if it ***does*** become a requirement.

Issue 4 is Accountability

The Government Performance and Results Act, or GPRA, passed in 1993. In it, Congress demanded that all Government programs contribute to measurable, desirable outcomes. The outcomes must benefit the public — and be something that the private sector cannot or will not do on its own. R&D programs are not exempt: they must produce measurable outcomes, for example, tons per year of pollutant reduced. These measures are used as part of the budget formulation process. The message for this audience is that, from a budget perspective, it is critically important that we hold to the schedule for fuel cell demonstrations and commercialization.

Starting in the FY99 budget cycle, DOE's budget requests to Congress will be based on amount of public good achieved. In this case, the public good is the potential for future emission reduction.

Issue 5 is budget pressure

The requirement to balance the budget is producing tremendous pressure on Congress to reduce discretionary funding, like R&D programs. As most of you know, the House FY98 appropriations bill told DOE to "down select" from three fuel-cell vendors to two.
The Senate language was silent on "down select," and it contained enough funding that we should

be able to continue with all three vendors. The issue will be resolved by the conference committee after Labor Day. We are looking at various scenarios, in the event the House version prevails, none of them pleasant. I hope we will not be forced into a down selection, particularly since a down selection is likely to drive the technology abroad, with the U.S. losing much of its investment.

I think it is important to have multiple vendors in the fuel cell program, and maintain the competition to reduce the cost of the commercial fuel cell product.

I conclude with a request: that ***you enter into the public debate on global warming***. Energy use has a major impact on the U.S. economy! Energy is a $560 billion per year business in the U.S. It accounts for 8 percent of our Gross Domestic Product.

Fossil fuels supply 85 percent of the energy we consume in the United States. And they ***will continue*** to be the dominant energy source in the U.S. for the foreseeable future.

DOE projects that fossil fuels will supply 88 percent by 2015. In the U.S., the use of fossil fuels has made our energy cheap — this has enhanced our quality of life — I like my dishwasher and I like my Chevy Blazer.

And it's fossil fuels that have made our economy competitive in the world market. This is our economic imperative — an abundant supply of low-cost energy. But we also have an environmental imperative — I want my children and grandchildren to live in a world that is non despoiled.

The U.S. needs to reconcile our economic and environmental imperatives. It's up to us in the scientific and technical community to weigh in on how best this might be done — or we will be told how it will be done.

Thank you.